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DIAPAUSE, VOLTINISM, AND FOODPLANTS OF *AUTOMERIS IO* (SATURNIIDAE) IN THE SOUTHEASTERN UNITED STATES

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ABSTRACT. *Automeris io* occurs throughout a wide latitudinal range. Across this range its voltinism is variable related to climatic conditions. It is single brooded in the northeastern United States and adjacent Canada; bivoltine in Louisiana, northern Georgia and northern Florida; trivoltine in central Florida; and multivoltine in southern Florida. With exception of southern Florida, one diapausing brood plus one or more non-diapausing broods occur annually. Freezing temperatures may increase the duration of pupal diapause 88 days or more. Florida males of the diapausing brood frequently are tawny brown in color similar to *Automeris* of the lower Florida Keys. Non-diapausing pupae cannot survive freezing temperatures. Mating behavior and mating techniques are discussed, new larval food plants observed during data collection are reported.

Additional key words: brood sequence, mating behavior, climate, phenotypic variation, rearing technique.

The Io moth, *Automeris io* (Fabricius), is one of several Saturniidae that has experienced a decline in numbers in the eastern United States in recent years. At one time considered a pest of cotton in the southern United States (Packard 1914), it has declined sharply in Florida and the Gulf States with the exception of Louisiana where it is still common. Although formerly abundant in the northeastern states, it now fluctuates from rare in mainland areas to common in Martha's Vineyard, Massachusetts, Block Island, Massachusetts (C. L. Remington pers. comm.), and parts of Cape Cod, Plymouth, Massachusetts. Dale F. Schweitzer (pers. comm.) indicates that it is common in southern New Jersey. It is never abundant in south central Pennsylvania; only 1–4 males per season were collected at UV light traps operated from dusk to dawn by Larry Kopp and myself over the past 30 years. From 1987–92 no males were taken.

From correspondence and visits with lepidopterists in Florida, it became evident that *A. io* is now apparently less common there than in the 1970's. The decline in numbers of *A. io* prompted me to expand my research from genetical analyses of the moth to factors affecting its life cycle in eastern United States. Mating behavior, diapause, and emergence patterns of *A. io* were studied.

The life history of *A. io* is well documented in published works that span two centuries, from the pioneer work of John Abbot (Abbot &

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Smith 1797) to the present (e.g., Eliot & Soule 1902, Packard 1914, Pease 1961, Collins & Weast 1961, Ferguson 1972, Weast 1989). Nevertheless, data concerning the number of broods, duration of flight periods, presence or absence of diapause, reproductive behavior, and preferred foodplants are incomplete.

This report is the result of more than ten years (1979–88) of collecting specimens, studying larvae in their natural habitat, rearing larvae for brood sequence study, and foodplant observations. All specimens collected by collaborators are deposited in the Peabody Museum of Natural History, Yale University. Specimens reared by the author in Pennsylvania are a part of the research collection at the Peabody Museum, Yale University.

MATERIALS AND METHODS

Data was collected with the assistance of fifteen lepidopterists located in areas assumed to be critical to the data base. These collaborators were selected on the basis of their familiarity with *A. io,* their ability to conduct long-term field work, and their willingness to participate in a project of several years duration. Preliminary data from these collaborators suggested that the sampling area could be divided into four regions based on the number of broods and seasonal flight period of *Automeris* (Fig. 1).

Region A comprises the Florida Keys south of Key Largo. *Automeris* collected in this area have been referred to as *Automeris io lilith* (Strecker). However, this insect is distinct from *A. io lilith* and will be described in a future publication. Region A has been sampled by Trehune Dickel, Homestead, Dade County, Florida from 1968–92.

In Region B *A. io* has four broods per year as demonstrated by sample sites at Jupiter, Palm Beach Co., Florida; Miami and Homestead, Dade Co., Florida.

In Region C *A. io* has three broods per year as demonstrated by sample sites at Kissimmee, Osceola Co., Florida and Tampa, Hillsborough Co., Florida.

In Region D *A. io* has two broods per year as demonstrated by sites at Gainseville, Alachua Co., Florida; Jacksonville, Duval Co., Florida; Decatur, Dekalb Co., Georgia; and Abita Springs, St. Tammany Parish, Louisiana. Specimens and data were obtained from the designated locality or within a twenty-five mile radius of that locality.

Whenever possible, broods in Georgia and Florida were reared under natural conditions in the vicinity of where ova or larvae were found. Larvae from genetic crosses were reared on foodplants known to be acceptable to *A. io.* Matings of adults from wild pupae collected in Georgia, Louisiana, and Florida were given a "choice test" of five host

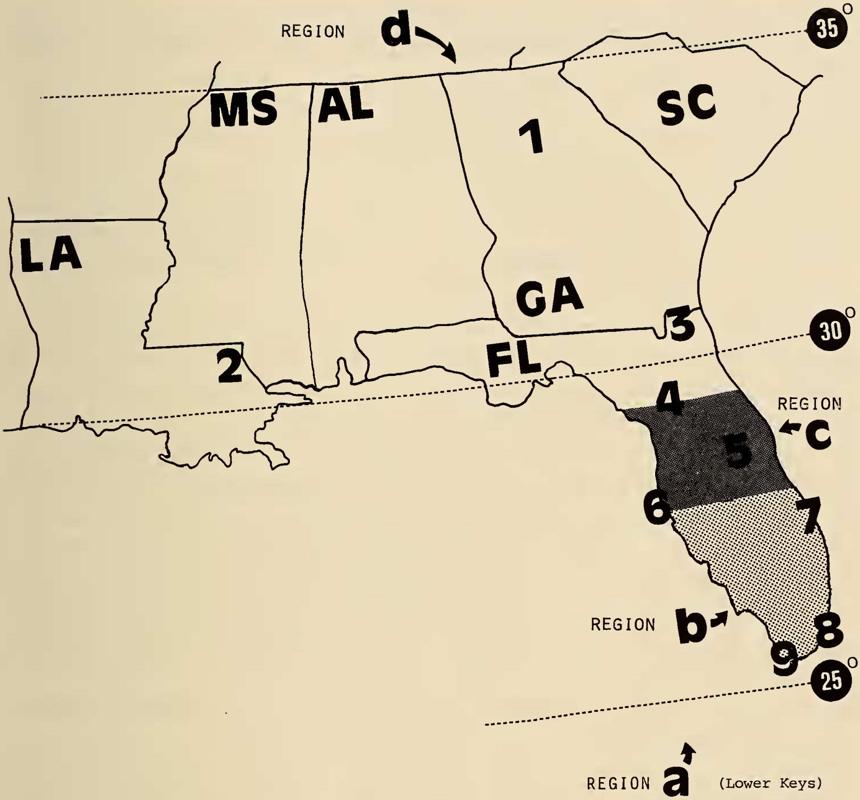

FIG. 1. Sampling Localities and Climatic Regions based on number of broods per seasons of *Automeris io*. Region A, lower Florida Keys omitted, *Automeris* in this area are not *Automeris io*; Region B, four non-diapausing broods: Region C, one diapausing brood and two non-diapausing broods; Region D, one diapausing brood and one non-diapausing brood. Numbers 1–9 areas where samples were taken. (1) Decatur, Georgia (DeKalb County). (2) Abita Springs, Louisiana (St. Tammany Parish). (3) Jacksonville, Florida (Duval County). (4) Gainesville, Florida (Alachua County). (5) Kissimmee, Florida (Osceola County). (6) Tampa, Florida (Hillsborough County). (7) Juniper, Florida (Palm Beach County). (8) Miami, Florida (Dade County). (9) Homestead, Florida (Dade County).

plant species known to be acceptable to *A. io*. Choice tests were conducted in eight inch glass containers with moistened paper towel covered bottoms. Immature and mature leaves of each foodplant offered were placed around the outer portion of the container, and the newly hatched larvae were placed in the center of the container. Larval foodplant selection usually occurred within 24 hours of hatching. When larvae were reluctant to select a foodplant the day following emergence, fresh leaves of the initial choice test plants were provided daily until the larvae selected a preferred foodplant or until they starved to death.

First instar larvae prefer fully expanded immature leaves; terminal leaf growth dessicates rapidly once removed from the branch and was rarely selected by larvae in choice tests.

Females of *A. io* mate readily if they are placed with males in a wire cage or gallon can with a wire covering; old burlap makes an excellent substrate for the copulating pair. Because copulation rarely occurs on the night of emergence of the female, males were placed in the breeding cage on the second night. Fresh leaves of an acceptable food-plant [e.g., *Prunus serotina* Ehrh. (Rosaceae)] in or on top of the breeding cage encourages females to mate and oviposit.

Fertile ova from controlled crosses were placed in petri dishes on slightly moistened paper towel material. The dishes were covered until the larvae hatched. First instar larvae were removed to small plastic containers with paper towel-covered bottoms and were fed young leaves of *P. serotina*. After the first instar molted, larvae were placed outdoors in large cloth sleeves on *P. serotina* or *P. virginiana* L. and left undisturbed for several weeks. During the final instars, sleeves were moved whenever the larvae had consumed most of the mature leaves preferred at this stage of development. Final instar larvae were placed in large screened cages with a mat of dry leaves on paper to provide a pupation substrate. Branches of the foodplant were supplied daily until all larvae spun cocoons. Leaves containing cocoons were not disturbed for 10–14 days to insure that all pupating larvae had transformed from larvae to pupae. Cocoons were removed, cleaned of excess leaves, and stored in cardboard containers at 5°C for the winter. Many cocoons of *A. io* are extremely thin and rupture when handled, exposing the pupae. Fifty percent or more of the cocoons were torn when removed from the leaves of the breeding cage; under laboratory conditions this did not affect viability. Pupae were removed from refrigeration 10–15 May each season and placed in wire cages at 21°C until eclosion (approximately 30 days). Matings in mid-June, when food supplies were ample, resulted in mature pupae in mid-September.

Collaborators ran UV light traps nightly each season (1979–85) until evening temperatures dropped below 8°C. [*Automeris io* rarely fly below this temperature.] Trapped specimens were killed, papered, and shipped to me. I spread and recorded data on all specimens as received. Wild larvae were reared in the vicinity of collaborators' homes on foodplants upon which larvae were found. In most cases larvae were not sleeved, allowing observation of predation and parasitism. Pupae and data concerning each reared brood were sent to me for analysis and recording. Foodplants supporting wild larvae were identified and checked frequently as larvae developed.

To determine the range of food plants used by *A. io lilith* in Florida, careful observations were made while collecting ova and larvae. Food plants where larvae were observed feeding were reported by eleven collaborators over a five year period.

RESULTS

Mating Behavior

Adult *A. io* emerged from late morning to mid-afternoon. The moths remained flightless until dark. If environmental conditions were favorable (i.e., temperatures above 10°C, low wind velocity, no heavy fog or rain), males engaged in preflight posturing—a flexing and fluttering of the wings for a short period (sometimes coupled with walking on the resting substrate)—followed by several minutes of rest before flight was initiated. Unless disturbed, females remained inactive the first night following emergence. At dusk of the second night, females performed the same preflight movements as males, then remained motionless on a leaf or trunk. Around 2200 h virgin females initiated "calling" behavior, releasing an attractant pheromone by extending and retracting the last abdominal segment at two second intervals for a short period of time (1–2 minutes). The abdomen always was oriented down wind for maximum pheromone dispersal. Based on attempts to attract wild males by exposing females under a wide range of environmental conditions, it appears that strong gusty winds, heavy rain, and dense fog (conditions that inhibit dispersal of the pheromone) all inhibited calling behavior by the female. Temperatures above 10°C were critical to initiation of calling behavior; at lower temperatures the female remained motionless on the substrate. Under laboratory conditions calling behavior was observed to have a circadian rhythm; caged females "called" every evening until they were allowed to mate. Matings of *A. io* (1964–91) occurred within 5–30 minutes after the female began calling. By 2300 h tethered unmated females sometimes continued calling but wild males rarely responded beyond that time.

Based on observations of over 500 controlled crosses resulting in fertile ova, the duration of copulation is about 90 minutes. A sudden drop in temperature below 8°C usually caused the pair to remain *in copula* throughout the night or until the temperature rose to about 8°C. On warm nights wild males usually flew away soon after separation from the female. On cool nights (below 8°C) the male remained beside the female throughout the night and the following day.

Diapause

Diapause in *A. io* occurs in the pupal stage. In the northern portion of its range, obligatory diapause occurs every generation, hence, the

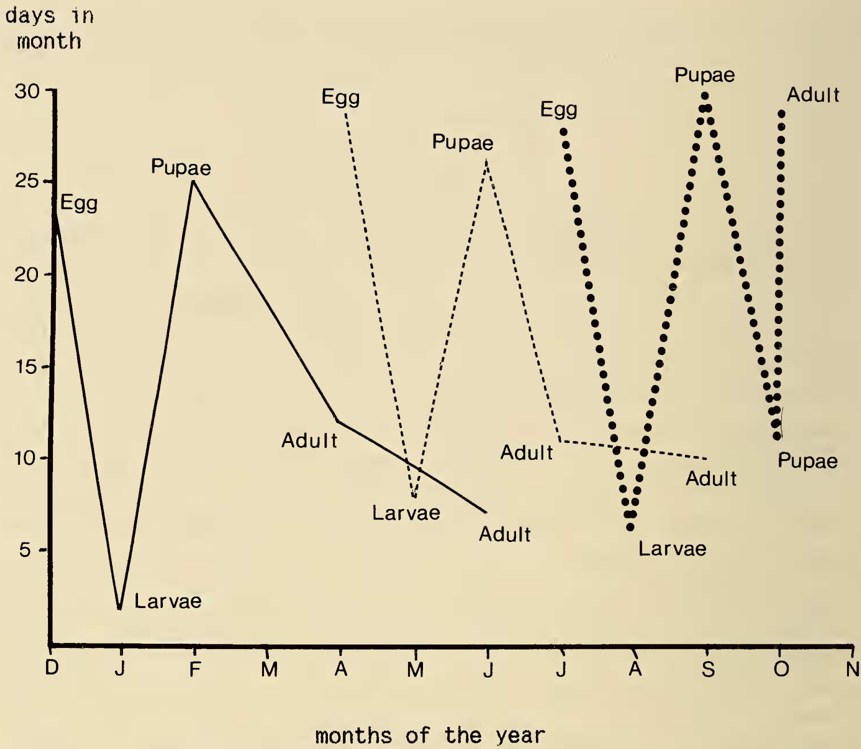

FIG. 2. Overlapping sibling brood sequences of a non-diapausing gravid *A. io lilith* female, Fort Lauderdale, Broward County, Florida, 24 December 1985 broods reared under controlled conditions. Brood 1: Eggs laid 25 December 1985, larvae 2 January 1986, pupae 26 February 1986, adults 12 April to 7 June 1986. Brood 2: Eggs laid 29 April 1986, larvae 8 May 1986, pupae 27 June 1986, adults 10 July to 9 September 1986. Brood 3: Eggs laid 29 July 1986, larvae 6 August 1986, pupae 30 September 1986–11 October 1986, adults 28 October 1986–8 November 1986. Remaining 22 pupae stored at 5°C.

species is univoltine. In the southern portion of its range, one or more non-diapausing generations are followed by a diapausing generation. In the southern tip of Florida, *A. io* was found to be continuously brooded, without diapause.

Diapause is controlled by photoperiod in many insects (Beck 1962, 1963, DeWilde 1962). Photoperiodism in facultative diapause affects every generation, however, the generation developing during late summer under decreasing day length enters diapause to survive the winter (Lees 1955, DeWilde 1962, Bursell 1964). The short day photoperiod, 12 hours or more of darkness per 24-hour day, applies to *A. io* as all diapausing generations occurred late in the season with pupation from September to November. Controlled crosses of *A. io* in early 1970's, of matings made in May with pupation in late August or early September, had a small percentage (8 to 15%) of non-diapausing males emerge in early October. Pupae from May matings that were refrigerated at 5°C as soon as they pupated had 10–15% greater pupal decomposition or desiccation during winter storage than the normal 3–5% that occurs in pupae from June matings. This suggests that those mortalities represent non-diapausing pupae. Offspring from matings (n = 400+) made in mid-June with pupation occurring in late September all appeared to diapause with minimal mortality during winter storage.

Males of diapausing generation of *A. io lilith* in Florida are phenotypically distinct from those of the non-diapausing generation(s). Males from diapausing pupae are tawny brown, whereas males from non-diapausing pupae are yellowish with a light suffusion of rosy-red scales. Dominick reported a similar situation in the bivoltine *A. io* in eastern South Carolina (Ferguson 1972:161).

Once diapause is induced, the duration of dormancy is influenced by temperature and moisture. In Pennsylvania and mountain regions north of Region D (Fig. 1), the thickness, amount of leaves and debris spun in fibers of the cocoon, the insulation effects of leaf cover, and depth and duration of snow and frost are factors that control developmental responses in diapausing pupae (Manley et al. unpubl. data). In Pennsylvania, warm weather during March and April usually results in the early emergence of many species of moths, including *A. io* (unpubl. data).

Non-diapause

Samples of *A. io lilith* pupae collected or reared during the winter months (Nov.–Feb.) in southern Florida and Key Largo (Region B, Fig. 2A) did not diapause. Non-diapausing pupae are sensitive to temperatures below 5°C and experience high mortality (90%) below this threshold. During 1984 four different broods of reared or wild pupae from Region B (Fig. 1) were shipped to Pennsylvania. Of nineteen pupae shipped from Jupiter, Florida to Pennsylvania during below freezing temperatures (5 January 1984), none hatched. Sibling pupae (n = 34) from the same brood reared in Florida were shipped 20 April 1984. Three males hatched during shipment, and the remaining 25 males and 6 females hatched in late April and May. Small samples of non-diapausing pupae from southern Florida shipped during warm periods when temperatures were above freezing, survived and began emerging shortly after arrival when held at 22°C.

The sequence of non-diapausing overlapping broods is shown in Fig. 2. These data represent the progeny of a wild female taken at UV light on 24 December 1985 at Fort Lauderdale, Broward County. Larvae

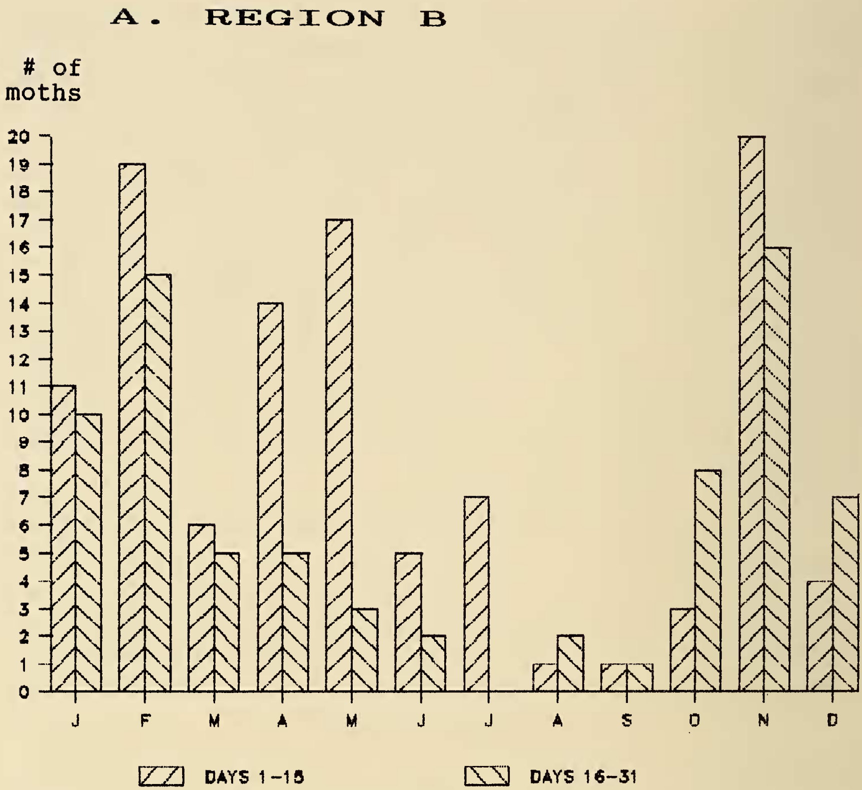

FIG. 3A. The flight periods and brood sequences of *Automeris io lilith* determined from males taken at UV light traps. Each bar represents a 15 day sample over a five or more year period. The diapause brood is black, non-diapause brood white. A) Region B, southern Florida (n = 103) 1983–87 show four non-diapausing broods annually; B) Region C, central Florida (n = 303) 1980–88 show one diapausing brood February–April, two non-diapausing broods May–July and August to November; C) Region D, northern Florida (n = 166) 1983–87 show an extended diapausing brood late March to June and one non-diapausing brood July–November. June population maybe mixed with late emerges of the diapausing brood and early emerges of the non-diapausing brood. Non-diapausing individuals of the diapausing brood could be flying in October–November.

were reared in Florida on *Ficus benjamina* L. (Moraceae) and pupae were taken to Decatur, DeKalb County, Georgia by Hermann Flaschka. Sibling matings were conducted on 29 April 1986, and larvae were reared on *Prunus serotina* L., with pupation about 26 June 1986. These pupae were sent to Pennsylvania, where third brood sibling matings were made 29 July 1986. Larvae were offered a choice of the following woody plants: *Prunus serotina* L., *Syringa vulgaris* L. (Oleaceae), *Hibiscus palustris* L. var. *disco belle* (Malvaceae), *Ficus benjamina* L., and *Quercus acutissima* Carruthers (Fagaceae). First instar larvae chose

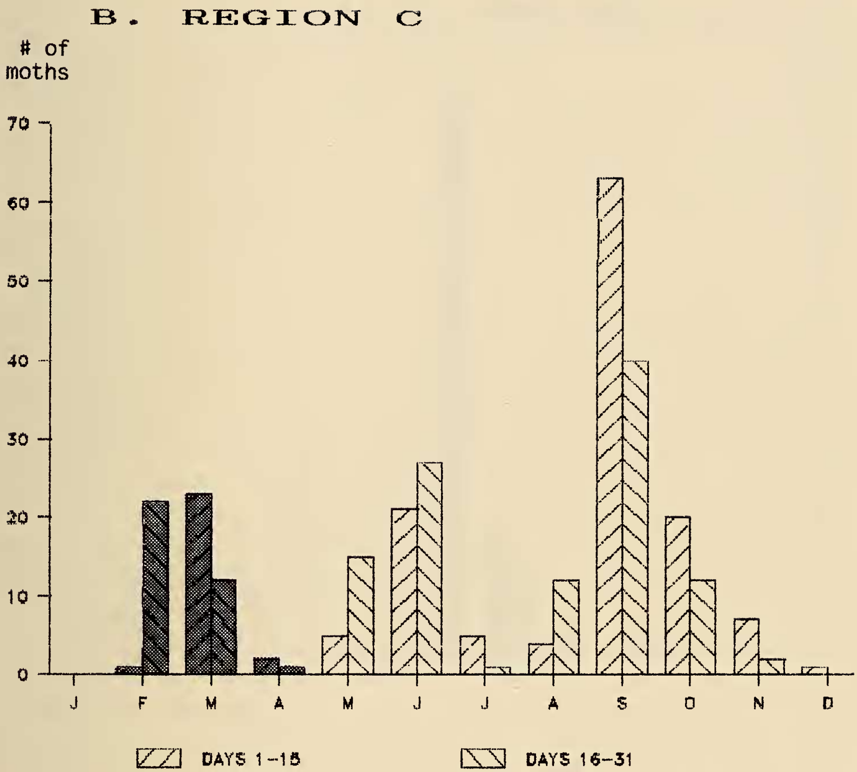

FIG. 3B. See caption for Fig. 3A.

Q. acutissima and were sleeved outdoors on this plant until they pupated in late September. Three males emerged 28 October and 6 and 8 November 1986. The remaining pupae (n = 22) of this non-diapausing population were stored at 5°C to determine if they could survive the winter; by early February all stored pupae and died.

Figure 2 demonstrates the overlapping brood sequence of *A. io lilith* in southern Florida. Circumstances prohibited the rearing of the fourth brood as no cooperator in southern Florida was available to rear it. Sibling matings of brood 3, normally flying in September and October in Florida, would have resulted in adults in December to complete the yearly cycle. Specimens have been collected every month of the year in Region B (Fig. 3A).

Diapause Duration

The survival of pupae shipped from Florida to Pennsylvania during below freezing temperatures suggests that diapausing pupae of *A. io*

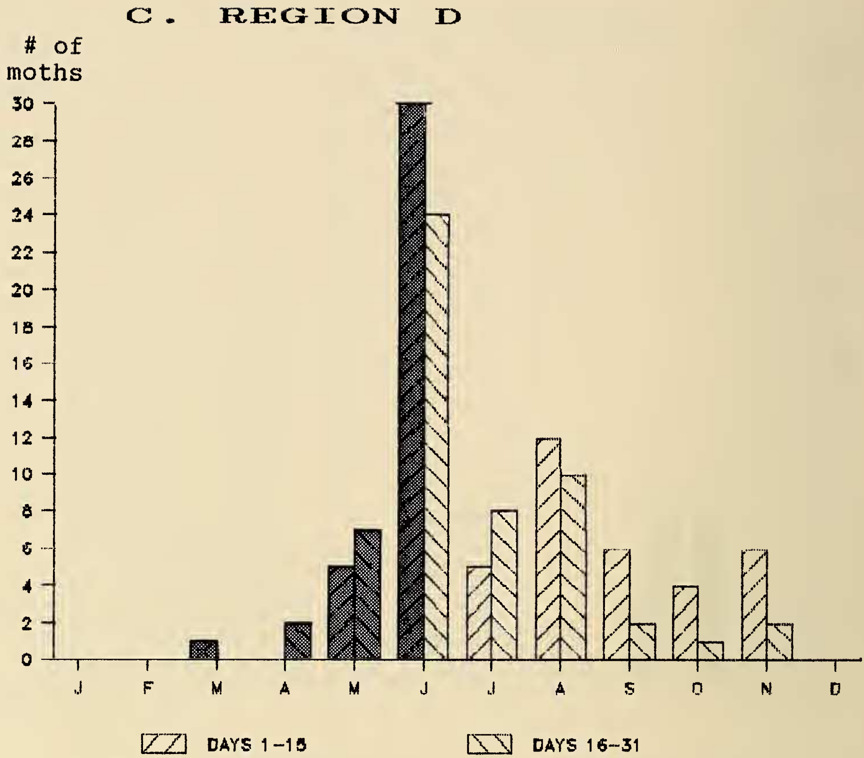

FIG. 3C. See caption for Fig. 3A.

lilith from central and northern Florida respond to sub-freezing temperatures by prolonged diapause. Cold hardiness of pupae of northern *A. io io* is demonstrated by the tolerance to a wider range of fluctuating and cold temperatures, often below −18°C. Over a three year period pupae (n = 25+) were placed in cloth or net mesh bags laid on the ground exposing them to outdoor conditions in Pennsylvania from November to June when they began to emerge as adults. Their emergence was predictable in that it coincided with the normal flight period of wild *A. io io* mid-June to mid-July.

Frequent Florida shipments of wild pupae collected by cooperators from Gainsville, Alachua County, southward to Tampa, Hillsborough County, during December and January 1985–86 were subjected to five or more days of below freezing temperatures en route to Pennsylvania. Pupae subjected to night temperatures −10°C to −15°C, day temperatures −4°C to −8°C, at some period during shipment north (30 to 40%) showed an extension of diapause emerging 88 to 121 days later than expected. Males from diapausing pupae normally emerging in mid-February to mid-April, emerged in August. These males were deep tawny brown typical of males from diapausing pupae in Florida. Sibling matings produced fertile ova in mid-August.

Diapausing pupae are able to survive exposure to below freezing temperatures during shipments north whereas non-diapausing pupae from southern Florida during the winter of 1985–86 were not able to survive. Larvae developing into pupae shipped in 1985–86 from the Tampa area fed during the short days of the late fall months when daily temperatures were 27–32°C.

Short periods of below freezing temperatures are common in the northern portion of Region C (Fig. 1), thus it is anticipated that periods of below freezing temperatures frequently would extend emergence of the diapause brood three weeks or more, depending on the duration and frequency of freezing temperatures. Late emerging adults of the diapause brood would be flying concurrent with the non-diapause summer brood. Tawny brown males of the diapause brood may appear in midsummer when yellow non-diapause males are flying. The appearance of brown males in the cooperators' five year samples varies in Regions C and D as does the number of below freezing periods in each during a particular season.

Emergence Patterns

Univoltine populations. *Automeris io* populations in its northern range are univoltine (Collins & Weast 1961, Ferguson 1972). Emergence varies from late May to mid-July in Pennsylvania, with a similar emergence pattern in New England and southern Canada. Wild males taken at UV light traps near Liverpool, Snyder County and Klingerstown, Schuylkill County, Pennsylvania show flight from 5 June to 17 July (one male taken on 5 August 1965); the majority of specimens were taken between June 14 and July 12. The flight period in Connecticut, deduced from the UV light samples of Sidney A. Hessel and the extensive collections (1950–60) of Charles L. Remington in the Peabody Museum, ranges from 2 June to 18 July (one early emergence of 12 May 1958). In southern New Jersey the extensive collections (1980–86) of Dale F. Schweitzer range from 10 June to 10 July with an occasional early or late emergence. These data suggest a six week flight period for univoltine populations.

Ferguson (1972:159) cited observations by M. C. Nielsen in Michigan of a small second brood; these are surprising, as our intensive studies in Pennsylvania showed no wild males coming to light in August and September. In captivity it is common for this and other univoltine Lepidoptera to show a partial hatch late in the year. Presumably, these late partial broods lack diapause and produce no surviving descendants.

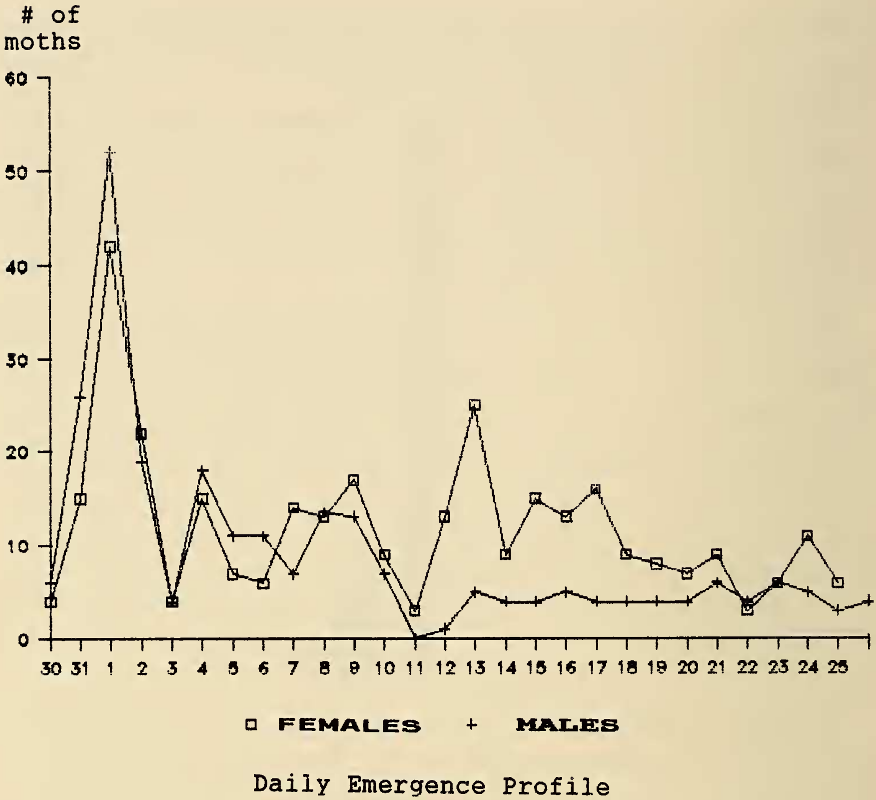

FIG. 4. Daily Emergence Profile of males and females from five crosses of Pennsylvania *Automeris io io* (n = 234 males, 140 females). Initial emergence 30 May 1985, final emergence 25 June 1985.

A series of crosses was made to determine the emergence pattern of females in relation to males in captivity and to evaluate sexual differences in emergence. Emergence data were taken from five univoltine crosses made in 1985 (Fig. 4). The range of emergence of these univoltine crosses was from 30 May to 28 June with no differences between sexes.

Bivoltine populations. Populations of *A. io* in coastal South Carolina, eastern Gulf Coast states (Georgia to Louisiana) and northern Florida (Fig. 1, Region D) appear to be bivoltine (see Fig. 5 and Fig. 3C). Sampling in the Murphy-Buford area of northern Georgia by Hermann Flaschka during 1979–85 (Fig. 5A) showed an extended diapausing brood, with the emergence of non-diapausing males in September (and possibly in October, as Dr. Flaschka usually terminated his UV light sampling in mid-September).

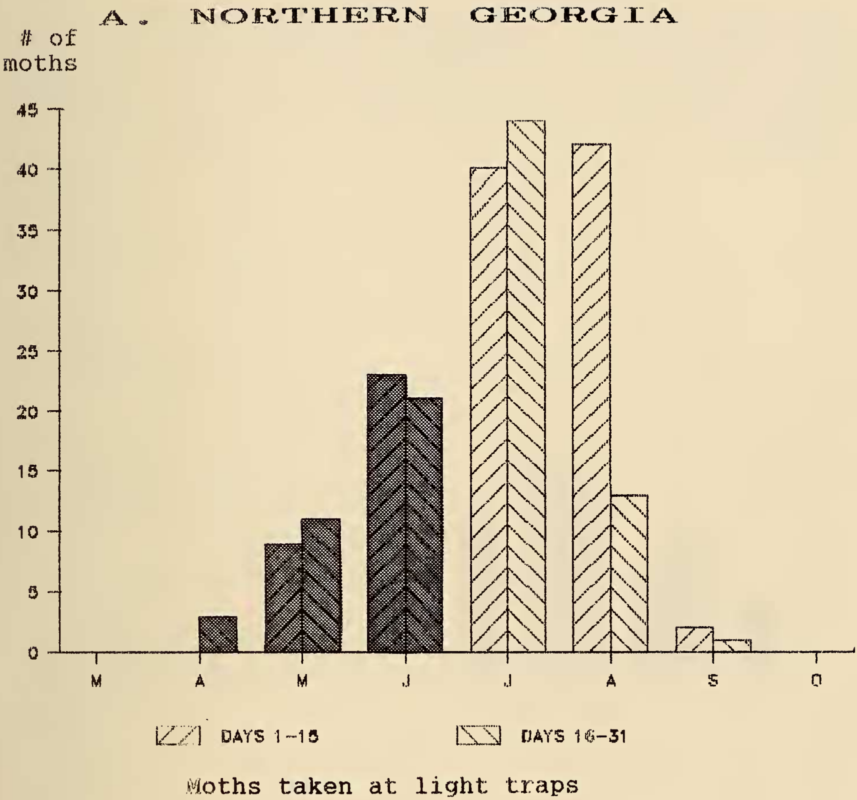

FIG. 5A. The number of male *Automeris io io* moths taken at UV light traps. Each bar represents a 15 day sample over a period of five or more years of a bivoltine population. The diapausing population is black, the non-diapausing population is white. A prolonged emerging diapause brood March to June gives rise to a large non-diapausing brood in July to September. The June population may be a mix of late emerges from the diapause brood and early emerges of the non-diapausing brood. A) Northern Georgia (n = 207) 1979–83; B) Southern Louisiana (n = 833) 1979–85.

In the 1969-70 crosses of Pennsylvania *A. io,* I observed that May matings produced a small percentage of non-diapausing pupae: 1969, 6 males and 5 females (n = 152 pupae) in late August and September; 1970, 27 males and 2 females (n = 255 pupae) in September and early October. In order to control fall emergence of May matings, mature pupae were refrigerated in early September at 5°C. This procedure produced 10–15% more mummified and decomposed pupae than occur in June matings. I concluded that many of these additional dead pupae were non-diapausing individuals that died during the long period of refrigeration. Future breeding programs (1971–86) were based on mid-

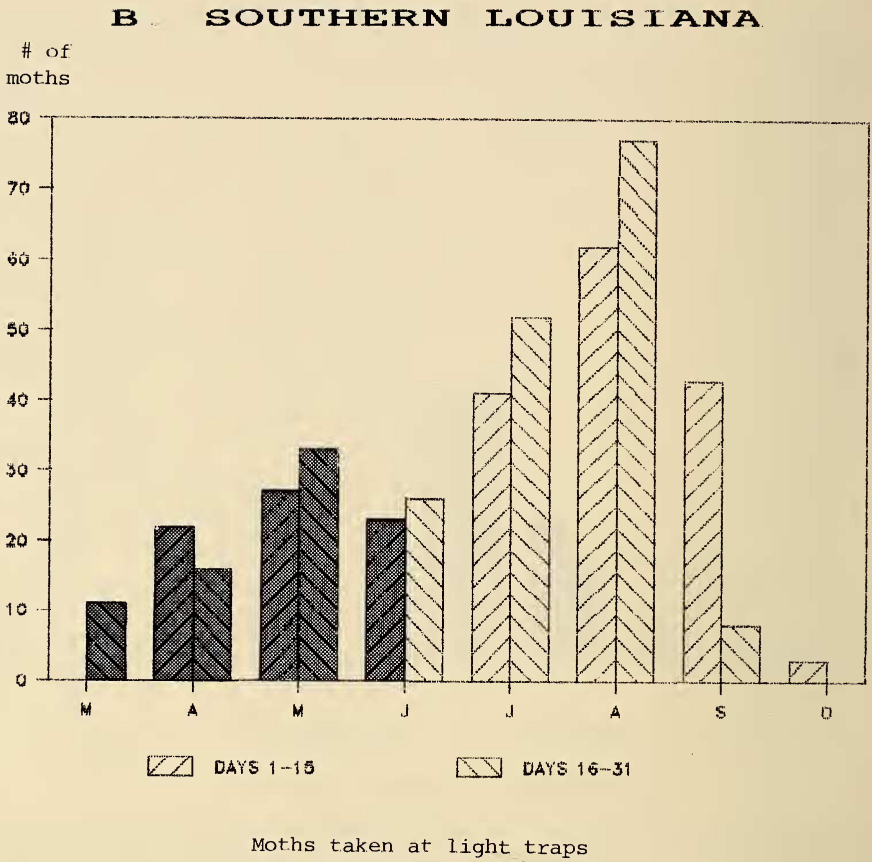

FIG. 5B. See caption for Fig. 5A.

June to early July matings, which matured in September, and all appeared to diapause.

Samples by Vernon Brou in St. Tammany and St. John's Parish in southern Louisiana (1979–85) illustrate a bivoltine life cycle with the emergence of many non-diapausing males in September and October. This sample area is 410 km further south than the Georgia sampling area. Matings from an extended diapausing brood flying late March to June produce non-diapausing adults flying from July to mid-September which in turn produce a diapausing brood; non-diapausing males of the diapausing brood emerge in September and October. One could expect non-diapausing *A. io* males from the diapausing brood to fly any month in the late fall and winter season in southern Louisiana. Our sample of 833 adults shown in Fig. 5B gave a 213 day flight period.

TABLE 1. Families of Florida food plants supporting larvae of *Automeris io lilith*, the name of the observer, year of observation and number of observations of each species are shown. Florida food plants previously listed Kimball (1965) are included.

Family Species	Source	Number of observations
Gramineae		
Zea mays L.	Kimball 1965	1
Myricaceae		
Myrica cerifera L.	Slotten 1985	2
	Baggett 1984	
Moraceae		
Ficus benjamina L.	Flaschka 1985	1
Celtis laevigata Willd.	Ritland 1985	2
	Kimball 1965	
Fagaceae		
Quercus acutissima Carr.	Manley 1985	1
Quercus virginiana Mill.	Baggett 1984	2
Quercus laurifolia Michx.	Baggett 1984	1
Quercus laevis Willd.	Baggett 1984	1
Lauraceae		
Persea americana Mill.	Kimball 1965	
Leguminosae		
Cercis canadensis L.	Baggett 1984	1
Phaseolus vulgaris L.	Kimball 1965	
Galactia glabella Michx.	Kimball 1965	
Galactia elliottii Nutt.	Kimball 1965	
Amorpha fruticosa L.	Kimball 1965	
Wisteria sinensis Sims	Baggett 1989	1
Rosaceae		
Prunus serotina Ehrh	Minno 1987	
	Flaschka 1985	3
Rosa rugosa Thunb.	Kimball 1965	
Magnoliaceae		
Magnolia virginiana L.	Baggett 1984	1
Malvaceae		
Hibiscus tiliaceus L.	Kimball 1965	
Hibiscus palustris L.	Jamieson 1984	9
	Jolly 1984	
	Minno 1987	
	Dickel 1987, 1986	
	Kutash 1985	
	Baggett 1984, 1985	
	Slotten 1985	
Gossypium herbaceum L.	Kimball 1965	
Cornaceae		
Cornus florida L.	Baggett 1984	1
Ericaceae		
Rhododendron catawbiense Michx.	Baggett 1987, 1984	2
Rhododendron japonicum Gray	Kimball 1965	
Rhododendron kaempferi Planch.	Kimball 1965	

TABLE 1. Continued.

Family Species	Source	Number of observations
Hamamelidaceae		
Liquidambar styraciflua L.	Baggett 1984	
	Lemberger 1984	3
Salicaceae		
Salix caroliniana Michx.	Kutash 1984	5
	Ritland 1986	
	Lemberger 1984	
	Baggett 1986	
	Minno 1987	
Turneraceae		
Turnera ulmifolia L.	Kimball 1965	
Bignoniaceae		
Tabebuia argentea Britton	Kimball 1965	
Ulmaceae		
Trema micrantha Blume	Dickel 1985	2
	Baggett 1984	
Palmaceae		
Rhapis flabelliformis L'Her.	Kimball 1965	
Sabal palmetto Lodd.	Kimball 1965	

The non-diapausing brood produced the greatest number of adults (Fig. 5B).

Northern Florida (Fig. 3C) was not as extensively sampled as other areas, however, continuous seasonal UV light sampling of other species of moths by H. D. Baggett, M. C. Minno, D. B. Ritland, and J. R. Slotten in the Gainesville-Jacksonville area recorded the appearance of *A. io* coming to their light traps 1983 to 1989. From these observations plus specimens of *A. io* in their collections, sufficient data were accumulated to estimate the flight periods of *A. io* in the southeastern portion of Region D (Fig. 3C).

Populations in northern Florida may encounter climatic conditions not normally encountered in central Florida. Unpredictable and severe frosts and freezes from December through March may kill larvae from matings of non-diapausing individuals. This portion of Florida is subject to jet stream patterns that bring cold air from the north; it is the coldest portion of the state, generally 4–7°C cooler than Region C to the south. The region also has the greatest diurnal temperature variation in March and April: 4–10°C at night to a high of 21–27°C in daytime. Frequent low temperatures during winter months impact the diapausing brood by delaying spring emergence and temperature of 0°C or lower may cause a "shock effect" on diapausing pupae, lengthening the emergence period into mid-summer.

Multi-voltine populations. Central Florida, a region north of Tampa, Hillsborough County and south of Orlando, Orange County, encompasses the southernmost extension of the Lower Austral life zone and the northern extreme of the sub-tropical life zone. The botanical "Fall Line", the northernmost extension of subtropical plants susceptible to cold temperatures, is in this area. Kissimmee, Osceola County, lies on this line and is in the center of Region C. Winter temperatures are moderate in this area, with cool nights (5°C) and occasional frosts in the northern portion. December and January are generally cool, but extreme fluctuations rarely occur. Frank Hedges collected UV light samples February to December 1980–82, 1986–88 shows a three brood sequence (Fig. 3B).

The diapausing brood adults emerge from late February to early April; matings of this brood produce Brood 2 (a non-diapausing brood) in late May to early July; matings from Brood 2 produce Brood 3 (a non-diapausing brood) in late August to October; matings of Brood 3 produce the diapausing brood in late September and October. Non-diapausing individuals of the typically diapausing brood fly in November.

Southern Florida (Region B, Fig. 3A) lies south of a line defined by Bradenton-Sebring-Port Pierce extending southward to Key Largo. Region A, Florida Keys south of Key Largo, is so designated as *Automeris* flying there are not *A. io lilith*. This subtropical area has abundant rainfall and warm night temperatures. Four or five non-diapausing broods fly in southern Florida. Cooperators report frequent observations of parasitized larvae. Larvae and one ova sample collected in this area were found to be heavily parasitized by braconid wasps suggesting cyclic reduction in adults during various seasons of the year. Another serious factor affecting abundance of *Automeris* in southern Florida is wild habitat destruction especially in the Keys.

Larval Foodplants

Tietz (1972:363–365) lists sixty foodplants for *A. io*, including most major groups of angiosperms. Tietz (1972) records a single conifer, *Abies balsamea* L. (Pinaceae), but this may not be a valid record. Over the last 25 years of breeding experiments with *A. io*, Larry Kopp and I have provided newly hatched larvae food choice tests covering a wide range of native trees and shrubs listed by Tietz (1972). This always was done when a new source *A. io* breeding stock was received from areas other than Pennsylvania. Native wild cherries, *Prunous serotina*, *Prunus pensylvanica*, and *Prunus virginiana*, were included in each taste test and were consistently preferred of all other food plants by first instar larvae of *A. io* originating north of central Georgia and southern

Louisiana. Larvae of all research crosses of *A. io* have been reared on wild cherry (*P. serotina*). Currently (1989–91) I am breeding *A. io* from Colorado where cooperators are compiling a list of new food plants as they collect larvae for this study. I have experienced no difficulty rearing Colorado larvae received in varying stages of instar development on wild cherry despite the fact that earlier instars fed on native Colorado plants and shrubs not indigenous to Pennsylvania.

Table 1 lists the 32 reported food plants (17 families) of *A. io lilith* in Florida. Food plants listed by Kimball (1965) are included.

Hibiscus, widely planted in urban areas, appears to be the most common food plant for *A. io lilith* in Florida. In native areas, *A. io* larvae were found most frequently on *A. caroliniana*. Florida larvae reared in Pennsylvania preferred black willow (*Salix nigra* Marsh) (Salicaceae) over pussy willow (*Salix discolor*) Muhlenb., white willow *Salix alba* L., weeping willow *Salix babylonica* L., and *P. serotina* offered in choice tests. Due to scarcity of *S. nigra*, final instar larvae were fed *P. serotina*, but with limited success as voracious feeding typical of this instar ceased. One of the most successful southern Florida broods was reared in Pennsylvania on *Quercus acutissima* Carr (Fagaceae).

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